

Vibration Control & Analysis



Time/Data

A GR COMPANY





The 1923V Digital Vibration Control System synthesizes and controls the excitation for vibration testing. The all digital system generates a random (Gaussian) sequence of numbers that are converted to an analog signal. The analog signal provides the excitation to a power amplifier that in turn drives either an electromagnetic or electrohydraulic shaker system. Additionally, the 1923V controls the vibrations experienced by the test specimen by comparing the spectrum of the observed vibrations with a stored reference. The Gaussian signal is controlled and synthesized in the frequency domain. The driving signal is obtained through a discrete Fourier transform performed by a high-speed special purpose fast Fourier transform processor. This also performs the spectral analysis of observed vibrations.

The 1923V represents the first major innovation in vibration testing in over a decade. Until its introduction, the function was performed by analog equipment consisting of a noise generator, 80 parallel variable gain band pass filters for spectral shaping of the spectrum, and 80 identical filters for estimating the spectrum of the observed vibrations.

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The 1923V system provides the following advantages:

GREATER RESOLUTION

The resolution of the control and synthesis can be extended by at least an order of magnitude without any noticeable cost increment. The 1923V can readily provide a resolution of 1/1000 rather than 1/80 which represents the economic limit of the analog implementation. This means that systems with sharper resonances can be controlled.

DIGITAL CONTROL

Digital systems can readily provide operator convenience features that would not be feasible in analog implementations:

- Conversational control mode.
Alpha-Numeric displays.
Interactive graphics for display and specification of test conditions.

Digital systems can effectively monitor test conditions and when necessary, initiate shut-down procedures that will minimize the possibility of damage to the test specimen.

ZERO-VARIANCE-NOISE

Because the system numerically synthesizes the (pseudo) random Gaussian sequences used for excitation, advantage is taken of this "a priori" knowledge in the estimation of the response spectrum of the shaker system. This permits the spectrum to be determined without the usual variance associated with the estimation of the spectrum of a Gaussian process. This feature (zero-variance-noise) permits, for the first time:

- Rapid stabilization of test conditions that permit valid short-term tests.
- Simulation of time-varying environments such as might be experienced by a missile during its launch phase.

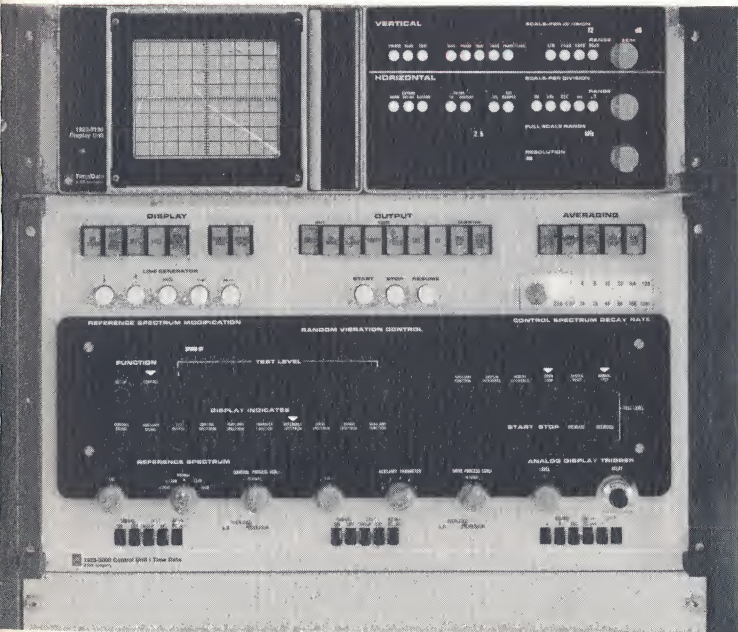
COMPLETE ANALYSIS

The same apparatus may be used to analyze the results for the vibration tests. The alternative software package permits the system to operate as a 1923 Time-Series-Analyzer which includes the following capabilities:

Complete analysis—The system design allows you to construct any desired compound processing and input/output operations for automatic or repetitive data-reduction routines. Parallel processing in both the processor and controller permits wide-band performance. Complex, repetitive sequences can be initiated automatically or at the push of a button, which eliminates the need for a trained operator to set up and supervise each measurement.

Pre-programmed pushbutton functions:

Direct/Inverse FFT
Auto-/Cross-Spectrum
Transfer/Coherence Function
Auto-/Cross-Correlation
Waveform Averaging



Action Initiation Controls:

START—initiates start of either set-up of parameters or test.

STOP—stops operation; initiates shut-down routine when in test mode.

INCREASE—causes test excitation to be increased to full level.

RESET—resets system into stand-by state after the completion or abortion of a test.



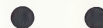
Function Selection:

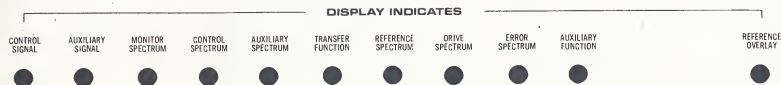
SET UP—puts system in set-up mode to allow operator to enter the test parameters. The **START** button must be depressed to initiate the conversational routine via the TTY. The **STOP** button may be depressed at any time to abort the **SET UP** state and return to **STANDBY**.

TEST—puts system in test mode. Press **START** to begin operation.

FUNCTION

SET-UP TEST





Display Selection Controls:

CONTROL SIGNAL— displays the analog control signal (Channel A).

AUXILIARY SIGNAL— displays the analog auxiliary (Channel B).

MONITOR SPECTRUM—displays auto spectrum of control signal.

CONTROL SPECTRUM—displays auto spectrum of control signal as it is used for control.

AUXILIARY SPECTRUM—displays auto spectrum of auxiliary (Channel B) signal. (Optional).

TRANSFER FUNCTION—displays transfer function. (Optional)

REFERENCE SPECTRUM—displays reference auto spectrum.

DRIVE SPECTRUM—displays auto spectrum of drive signal.

ERROR SPECTRUM—displays the ratio of the control and reference spectrums.

AUXILIARY FUNCTION—displays the auxiliary function. (Optional).

REFERENCE OVERLAY—allows the reference spectrum to be superimposed on any other display.

Status Indicators

Five indicator lamps—STANDBY, SET UP, RUN, COMPLETE and ABORT—are used to indicate the major state that the system is in. ABORT is indicated if, for any reason, a test stops prematurely,

NOT EQUALIZED is indicated whenever the control spectrum is not within tolerance.

INVALID PARAMETER is indicated whenever an illegal parameter is selected from the control panel.

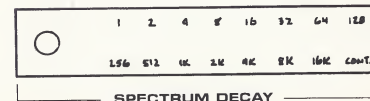
Spectrum Modification

Allows modification of the reference spectrum. The frequency band that is to be modified is selected by specifying the upper and lower frequencies of the band. The level increment is also selected (in dB).

Control Spectrum Delay:

Allows the exponential time constant of the control loop to be selected. The numbers refer to the effective number of ensemble averages in the control spectral estimate. The number of statistical degrees of freedom is approximately twice this number.

STATUS



Example

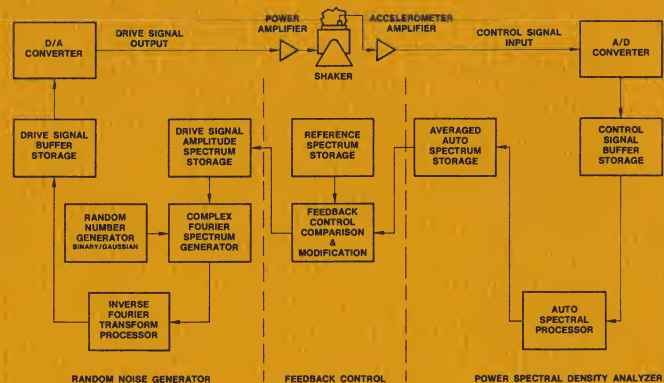
A typical set-up procedure for a random test is shown in Fig. 1. By selecting SET-UP as the function the machine is to perform, and pressing START, the operator is put into communication with the machine via the tele-typewriter. The machine asks questions which the operator responds to by typing numbers. After answering all the questions, and making any necessary corrections, the operator may elect to have the test parameters punched on paper tape so that the next time that the same test is to be performed it may be set-up by just loading the tape. When ready to perform the test, the operator selects CONTROL and presses START.

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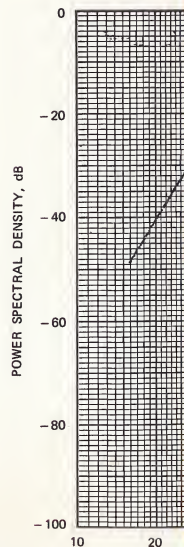
ENTER PARAMETERS 1=YES 0=NO: 0
CORRECTIONS 1=YES 0=NO: 0
LIST 1=YES 0=NO: 1
  1 BANDWIDTH, HZ.: 5120
  2 FREQUENCY RESOLUTION 64/128/256/512: 256
  FREQUENCY INCREMENT, HZ.: 20
REFERENCE SPECTRUM:
  3 INITIAL SLOPE DR/OC1: 24
  4 FREQUENCY HZ.: 500
  LEVEL G50R/HZ.: 0.1
  5 FREQUENCY HZ.: 2500
  LEVEL G50R/HZ.: 0.1
  6 FINAL SLOPE DR/OC1: 48
  7 ZERO VARIANCE MODE 1=YES 0=NO: 1
  
```

Fig. 1

Functional block diagram of random vibration control system.



XY Plot Spec



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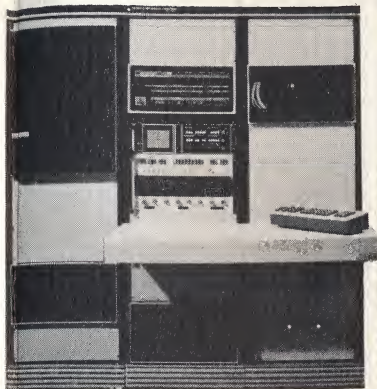
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Please Send Information On:

- ☐ Random Control
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- ☐ Transient Control
- ☐ Signal Analysis
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- ☐ I would Like to be on Mailing List

☐ My Application is _____

Name: _____

Title: _____ Dept: _____

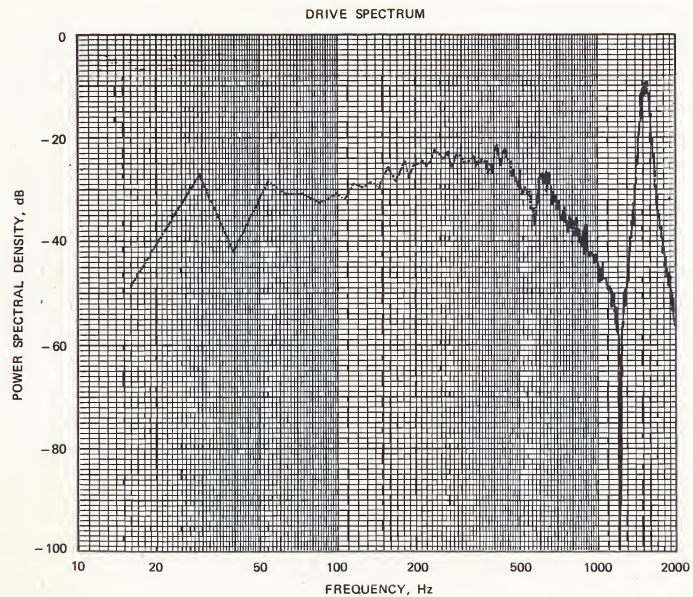
Company: _____

Address: _____

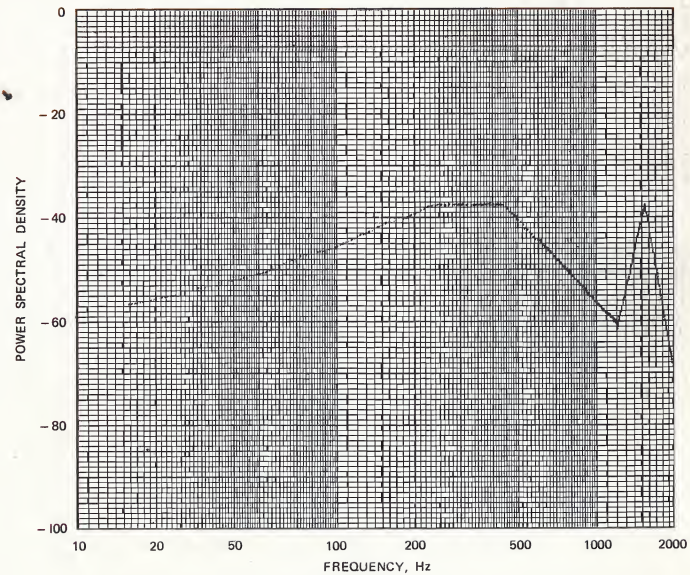
City: _____ State: _____ Zip: _____

Phone: _____ Area Code: _____

XY Plot Specimen



REFERENCE & CONTROL SPECTRUMS





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